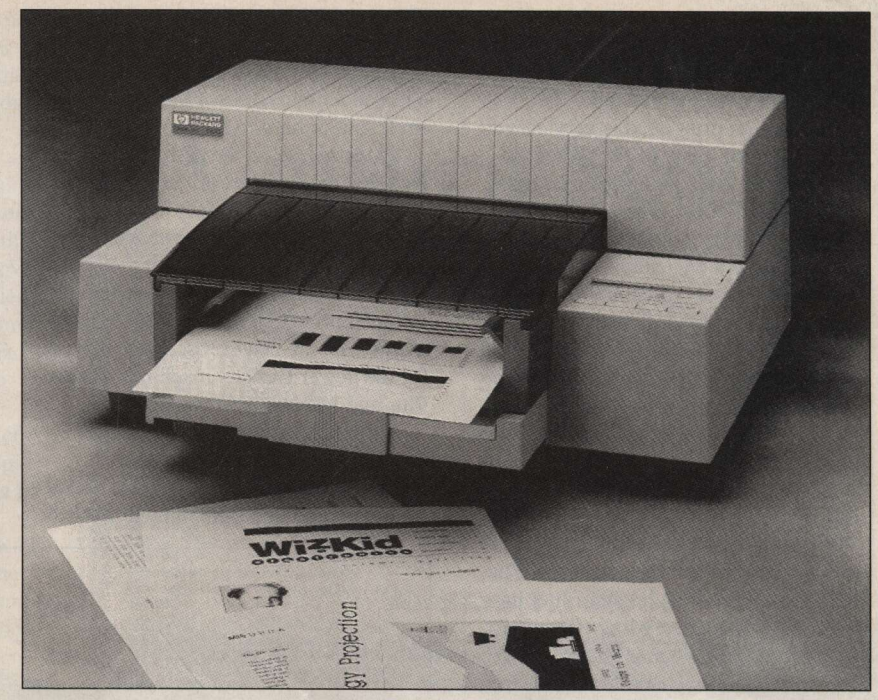


INK-JET PRINTING

Ink-jet printers can give you the quality of a laser printer at the price of a dot matrix. Simon Williams explains the benefits and drawbacks of this new technology.

Between the cost of a 24-pin dot-matrix printer and a personal laser, lies a select band of machines operating on a third, unique, principle. These printers can better the resolution of a typical laser, print as fast as a 24-pin and make less noise than any other type of ink-based printer. Described as the poor-man's laser and the dot-matrix for the migraine sufferer, the ink-jet printer offers aspects of both technologies.

A recent survey by the market analyst Dataquest predicts sales of ink-jet printers rising to 15 percent of the market, over double the 1989 share. Sales of the Hewlett-Packard DeskJet, perhaps the best known ink-jet printer, have been outstanding and the price has dropped consistently, with the latest Deskjet 500 model having a price of just £599 (plus VAT). Discount prices will probably put it under (£400 plus VAT), not much more than a good 24-pin printer. Ink-jet technology is also making high-resolution print available to the portable market.

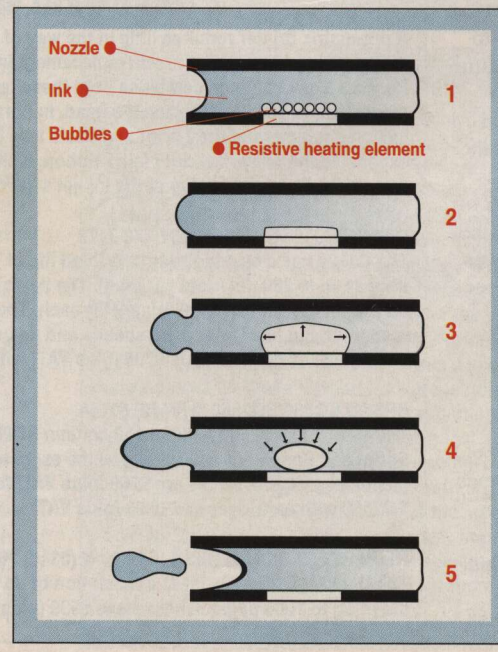
The ink-jet principle started, says Canon, with one of its researchers. He was intrigued to find that touching the needle of an ink-filled syringe with a soldering iron caused a jet of ink to be shot from its tip. Investigations continued and the principle was built into several successful Canon 'bubble-jet' printers.

BUBBLE POWER

'It's so simple, it's brilliant' describes the workings of an inkjet printer where the only moving part is the ink itself. In the same way that a dot-matrix printer has a matrix of tiny pins in its head, the ink-jet uses a grid of even smaller nozzles, each around 40 microns in diameter. Specially formulated ink flows into each nozzle from a reservoir, that is normally a part of the print head itself.

When a signal is received for a particular nozzle to fire, a minute resistive heating element, built into the base of the nozzle, heats up. The ink close to the element vapourises almost instantly and creates a tiny bubble. As the bubble expands, ink in the nozzle is forced outward and a droplet is ejected from the open end of the nozzle, towards the paper. As soon as the heating element is de-energised, the bubble collapses and a partial vacuum is created in the nozzle. This has the effect of sucking more ink in from the reservoir.

The whole process happens in a fraction of a second, allowing droplets to be ejected at over 300 per inch. Even so, the print head of an ink-jet printer can still travel at speeds very similar to those of typical dot-matrix printers. Unlike the dot-matrix printer there is no heat penalty to be paid for fast printing. Since



● As the resistive heating element is energised (1), a series of bubbles form almost instantly. They quickly coalesce (2) into one bubble covering the whole of the element. As heating continues (3), the pressure exerted by the bubble forces ink out of the end of the nozzle. When the heater is deactivated (4), the vapourised ink turns back to liquid and reduces rapidly in volume. By the time the bubble disappears (5), the droplet is heading towards the paper and the vacuum left by the bubble sucks more ink from the print head reservoir. (Diagram courtesy of Canon Limited.)

there are no moving parts within the print head, friction is negligible and the only governing factor is the speed of bubble creation and collapse.

An ink-jet print head is very easy to construct, and many of the principles used in microchip manufacture can be used to good effect. The nozzle and heating elements can be deposited as a series of layers on a silicon substrate. An inkjet head has a typical life of one million characters and, with its integral ink reservoir, can be replaced simply as a single unit, though there is, as yet, no way of recycling the materials used, or refilling the reservoir. Ink-jet print heads have up to 64 separate nozzles.

INK BLOTS

The main difference between laser and ink-jet print is the state of the ink. The liquid ink used in an inkjet printer has of necessity to be of very low viscosity. This means that when it hits the paper, it will spread into the fibres if the surface is at all absorbent. This spread will give ink-jet print a slightly more ragged appearance than laser print. The laser uses a dry, powder-based ink, which spreads only slightly when fused to the paper by its heated roller. The spread is much less pronounced than with an ink-jet, so paper quality is less critical.

The liquid ink used in ink-jets also takes a finite time to dry. This accounts for the rather odd paper feed arrangement on DeskJet printers. The paper is fed from a bottom tray and makes a horizontal U-turn to be fed out onto two lateral supports positioned directly above an output bin. This bin itself lies above the feed tray. The supports delay the output of each sheet just long enough for the ink to dry, before moving apart and letting the sheet drop through to the bin below. Cunning!

The carriage of an ink-jet printer is based heavily on designs used for dot-matrix machines. The print head has to be moved across the carriage in the same way and needs to be positioned as accurately. The head can be fashioned almost entirely of plastic, apart from the nozzles themselves, and the whole assembly is a lot lighter than the head of a dot-matrix printer. This means that the head transport can be made to allow for lower inertia, cutting the size of stepper motors and other components which control its motion.

LEARNER DRIVERS

Software standards – the set of 'control codes' used to select effects such as bold and italic type – are not as well designed for ink-jet printers as for dot matrix or lasers, partly due to the comparative newness of the technology. The original Hewlett-Packard DeskJet had partial compatibility with early LaserJet codes. The main difference concerned the use of fonts and commands which worked on a page basis. Since the DeskJet prints a line at a time, some of these were irrelevant or hard to implement.

Nonetheless, in the early days of the DeskJet, the LaserJet drivers of software applications were brought into play. More recently, applications have introduced DeskJet drivers in their own right. Ironically, the DeskJet and original LaserJet printer standards (PCL3) have merged, so the need for separate drivers for the newer DeskJet machines like the Plus and 500 has diminished.

Hewlett-Packard also provides an Epson FX emulation as a plug-in cartridge for its DeskJets. This is useful for compatibility's sake, though it's less flexible than the LaserJet standard. Canon offers IBM Proprinter compatibility on its BJ range of inkjets, though it's own printing standard for the machines gives similar facilities to the DeskJet range. The PaintJet range has become something of a software standard in its own right and packages which can use colour usually offer a PaintJet driver as standard.

As with dot-matrix and laser printers, you can print PostScript files to most inkjets using a PostScript emulator, like *Freedom of Press*. *FoP* and *GoScript* support the DeskJet and the Canon BJ series, and *FoP* will print colour PostScript files to a PaintJet.

High quality internal fonts are available with each machine, though

● This neat little Deskjet component lets you replace ink supply and print head all in one go. Don't be fooled by the sardine tin packaging – this little black box will set you back around three times as much as a dot matrix printer ribbon.

CONSUMABLES AND COSTS

A dot-matrix printer requires little in the way of consumables, other than the occasional printer ribbon. The ink-jet needs replacement ink and eventually, a new head. The Hewlett-Packard DeskJet range combines both these replacements into one operation. When you renew the ink you also replace the head. In normal use, a Deskjet head lasts for around a million characters of draft print and costs less than £13 at street prices. This is more expensive than a typical dot-matrix ribbon, which will give over two million characters for around £4. The print quality of the ink-jet's 'jet' black ink is much higher, however.

CANON BJ10e/BJ130e ● 081-773 3173
The BJ10e has a cartridge with a quoted life of 700,000 characters, two typefaces and can print at up to 360 dpi (dots per inch). The basic price of the BJ10e is £345 (plus VAT) with ink cartridges priced at £17.99 (plus VAT) each. The larger BJ130e offers the same print resolution but has faster print speeds and an ink cartridge life of a million characters. The basic price of the BJ130e is £795 (plus VAT) with cartridges at £13 (plus VAT) each.

EPSON SQ850/SQ2550 ● (0442) 61144
The 80 column SQ850 and the 132 column SQ2550 both offer Roman, Courier, Prestige, Script and Sans Serif typefaces and the expected life of the ink cartridge is over three million characters. Prices are £769 (plus VAT) for the SQ850 and £999 (plus VAT) for the SQ2550 with cartridges at £28.99 (plus VAT).

HEWLETT-PACKARD DESKJET 500 ● (0344) 360000
The DeskJet 500 can print at a resolution of up to 300 dpi and the ink cartridge has a quoted life of up to 1000 pages. The price is £599 (plus VAT) with cartridges at £14.80 (plus VAT).

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5 free expansion slots.
Mouse,MS DOS 4.01
GW BASIC, MS WINDOWS 3

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Landmark Speed 58.7,MIPS 7.779,
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80387-33 or weitek maths socket
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1.2MB 5.25" and 1.44MB 3.5" FDD,
2 serial 2 parallel ports,
5 free expansion slots.
Mouse, MS-DOS 4.01
GW BASIC, MS WINDOWS 3.

M386C-044	44MB(25ms)	£1895.00	£1995.00	£2145.00
M386C-090	90MB(25ms)	£2139.00	£2239.00	£2389.00
M386C-180	180MB(17ms)	£2329.00	£2429.00	£2579.00
M386C-320	320MB(16ms)	£3249.00	£3349.00	£3499.00
M386C-640	640MB(16ms)	£3369.00	£3469.00	£3619.00

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64K cache RAM(25ns)
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2MB RAM expandable to 16MB,
80387-25 maths coprocessor socket,
1.2MB 5.25" and 1.44MB 3.5" FDD,
2 serial 2 parallel ports,
5 free expansion slots,
Mouse, MS DOS 4.01
GW_BASIC,MS Windows 3

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M386B-135	135MB (17ms)	£1809.00	£1909.00	£2059.00
M386B-180	180MB (17ms)	£1889.00	£1989.00	£2139.00
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1.2MB 5.25" and 1.44MB 3.5" FDD,
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5 free expansion slots.
Mouse,MS DOS 4.01
GW BASIC, MS WINDOWS 3.

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5 free expansion slots
Mouse, MS DOS 4.01
GW BASIC, MS WINDOW

M386SX-044	44MB (25ms)	£899.00	£999.00	£1149.00
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1MB RAM (max 4Mb on main board),
80287 maths coprocessor socket,
1.2MB 5.25" FDD (1.44MB 3.5" optional),
2 serial 2 parallel ports,
5 free expansion slots.
Desktop Case
MS DOS 4.01 & GW BASIC,

M286A-020	20MB(65ms)	£635.00	£735.00	£885.00
M286A-044	44MB(25ms)	£675.00	£775.00	£925.00
M286A-090	90MB(25ms)	£845.00	£945.00	£1095.00
M286A-001	1-FDD	£510.00	£610.00	£760.00

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GW_BASIC,MS Windows 3

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3free expansion slots.
1MB RAM on M286 exp.to 4MB,
2MB RAM on M386 exp.to 8MB,
Mouse,MS DOS 4.01
GW BASIC,MS Windows 3

M286P-LCD	80286-12	44MB(25ms)	£1765.00
M386SXP-GP	80386SX-16	44MB(25ms)	£1905.00
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COMPUTERS & ELECTRONICS

until recently Courier and Letter Gothic seemed to be the favourites. Neither of these faces is very attractive, but others are available through plug-in cartridges.

JETTING AWAY

The future of the inkjet printer looks extremely good. Although it'll be some years yet before it takes over from the dot-matrix printer as the standard low-cost print technology, there is a series of reasons why this will eventually come about. The advantages of dot-matrix technology over the daisywheel are versatility in printing graphics and speed. By building up each character from a matrix of dots, a typical 24-pin printer can print just about anything in the way of text or graphics.

There are certain jobs where the ink-jet is not a direct replacement for the dot-matrix printer. One notable example is multi-part printing. If an application requires several copies of a document, as with invoicing for instance, then the non-impact technology of the ink-jet is no use. The dot matrix, which can create an impression through three or four-part paper has a definite advantage.

When compared to the inkjet, though, it loses out on a number of counts. The size of a physical pin, even in a 48-pin printer, is a lot larger than the diameter of the nozzle in an inkjet head. This means that the size of a single dot is also a lot larger and, although the dot matrix may be able to lay down the same number of dots to the inch, it can never produce the definition of an inkjet. The dot matrix printer is also approaching the limits of its technology, as a finer pin automatically means a more fragile pin.

Add to this the poor contrast of dot matrix print and the fact that the paper is physically damaged by the impact of dot-matrix pins (try a quad density graphics dump if you don't believe this), and you begin to wonder why dot-matrix printers are so popular.

The main reason is cost. At discount prices, a nine pin dot-matrix printer can be had for a little over £100, around a third of the discount price of the Canon BJ-10e. Even though the inkjet's print quality, facilities and noise levels are a lot lower than any dot-matrix, the inkjet is still beyond the reach of many individual's pockets. Printers such as the Star LC200 also offer cheap colour output, which isn't available yet on the cheapest inkjets, and you can see the dot matrix still has advantages.

These advantages are diminishing, though, and the day of the £150 300 dpi inkjet are not far away. Not only is the inkjet printer a better long-term bet for quality, jet-black print (sic), but the head mechanism is a lot cheaper and easier to produce. With these double benefits to user and manufacturer, the future of the

HEWLETT-PACKARD DESKJET INK-JET

HEWLETT-PACKARD LASERJET III LASER

Ventura Scoop
SPECIAL EDITION
APTOS POST TYPOGRAPHY
MARCH, 1987
Xerox Shows Off Ventura Publisher at Conference
BEVERLY HILLS (VP) — Xerox Corporation has introduced version 1.1 of its first electronic publishing software product that runs on industry standard personal computers. Xerox chose the Seybold Conference to announce the price and availability of the new revision to the industry standard software package. Conference attendees were impressed by the eighty-one new features, all of which
Shuttle
This is an example of an AutoCAD DXF file converted using the external DXF converter, and then brought into Ventura Publisher using the Load Text/Picture function.
Version 1.1 Redefines

● As you can see from the comparison of these two 'Scoop' pages from *Ventura Publisher*, the DeskJet goes a long way towards the resolution and quality of a laser

MIXING COLOURS

There's no reason, of course, why the ink in an ink-jet has to be black. Since the ink-jet is the only common printer technology which uses liquid ink, there is also a unique scope for the blending of coloured inks to produce multi-coloured prints.

Colour ink-jets are available from Xerox and Hewlett-Packard, among others, and the Hewlett-Packard PaintJet has quite a following in medium-resolution graphics work. This printer can print at up to 180 dpi and by mixing inks provides a palette of nearly 1000 colours. It uses four separate jets, spraying cyan, yellow, magenta and black. This is the same colour system as is used in professional colour printing, only there the separate colours are overlaid in different parts of the printing process.

The PaintJet is a successful colour printer, but has limited resolution and works best with specially chalked paper, which has a low ink absorption. How about a colour version of the DeskJet? While Hewlett-Packard is not prepared to comment on such a machine, it's known to be working on a high-resolution colour inkjet, and it would certainly be a very interesting printer. The main technical difficulty would probably be positioning separate sets of nozzles accurately enough to overspray four colours at this resolution.

A lot of work is going into colour printing at the moment. From colour lasers and dye sublimation printers at the top end of the market, to colour dot-matrix machines at the bottom, colour is becoming increasingly important for business, as well as graphic output. There is at present a gap between these two extremes, filled only by ink-jet technology. The main limit to this at the moment is resolution, but that also may soon be a thing of the past.